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(54) Method and apparatus for reducing humidity

(57) Condensation in a building, e.g. a domestic dwelling, is reduced by a unit comprising a humidity sensor (36), a fan (18) for drawing air into the building in response to the humidity sensor, a heating element (22) for heating the air thus drawn in, and temperature control means for controlling the heating of the air. The outside air produces an over-pressure in the building which acts (i) to expel humid air through gaps in the building and (ii) to raise with the interior air and reduce its humidity. The fan (18) is turned off when a target set humidity is reached. Humidity sensor (30) detects the humidity of the outside air and can adjust the target level.

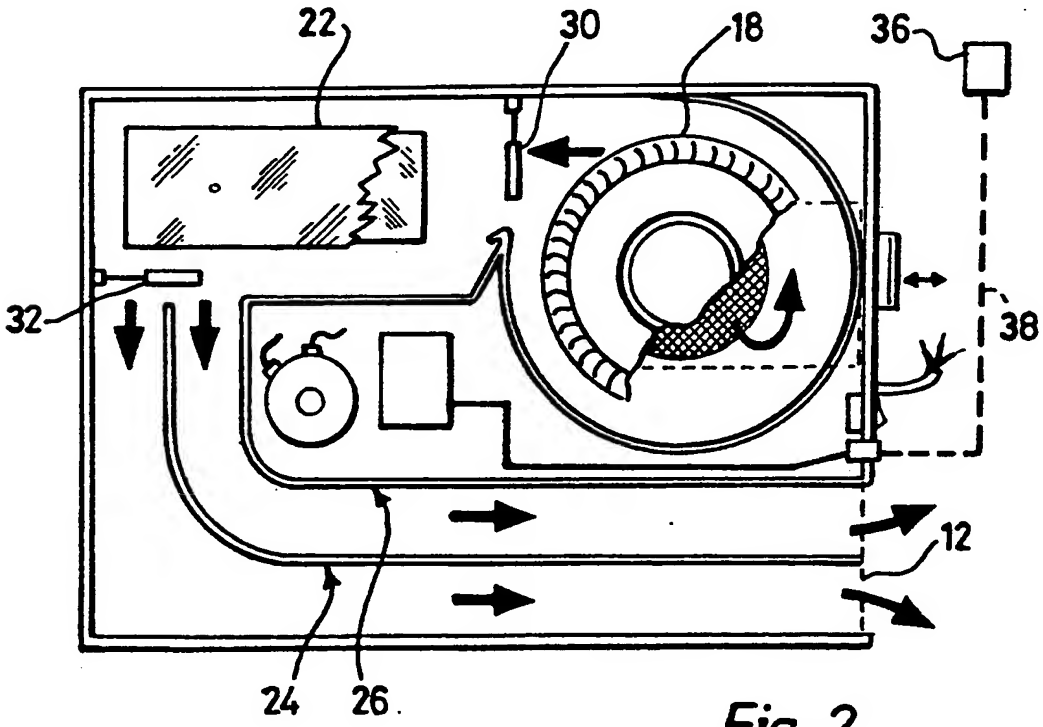

Fig. 2

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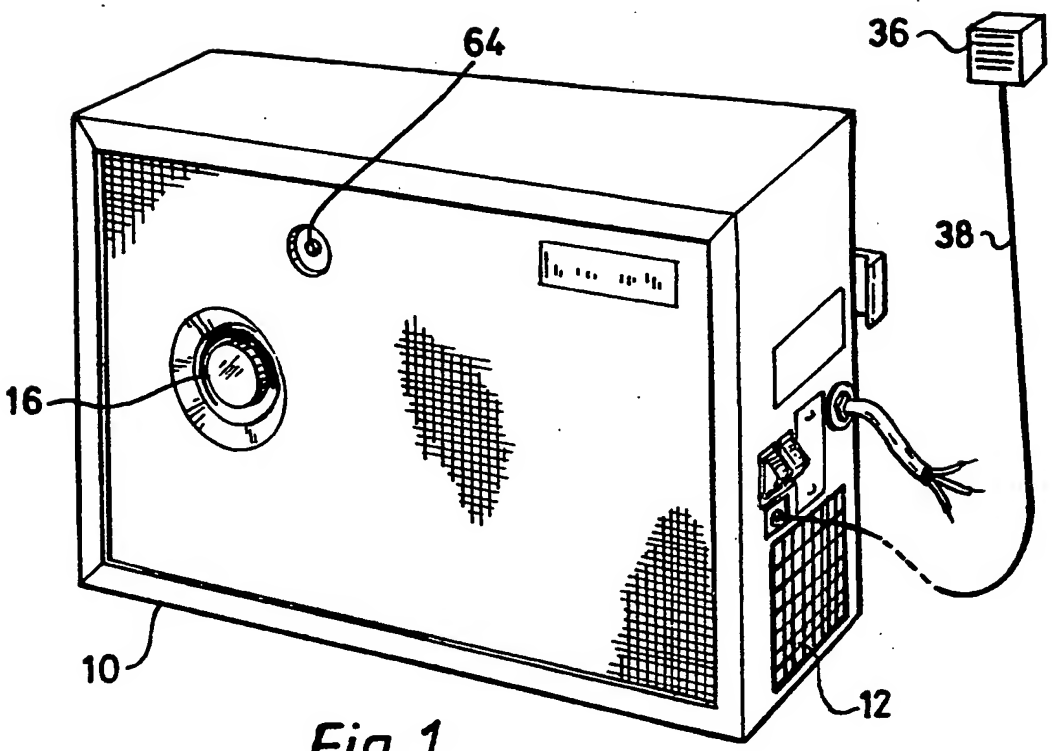

Fig. 1

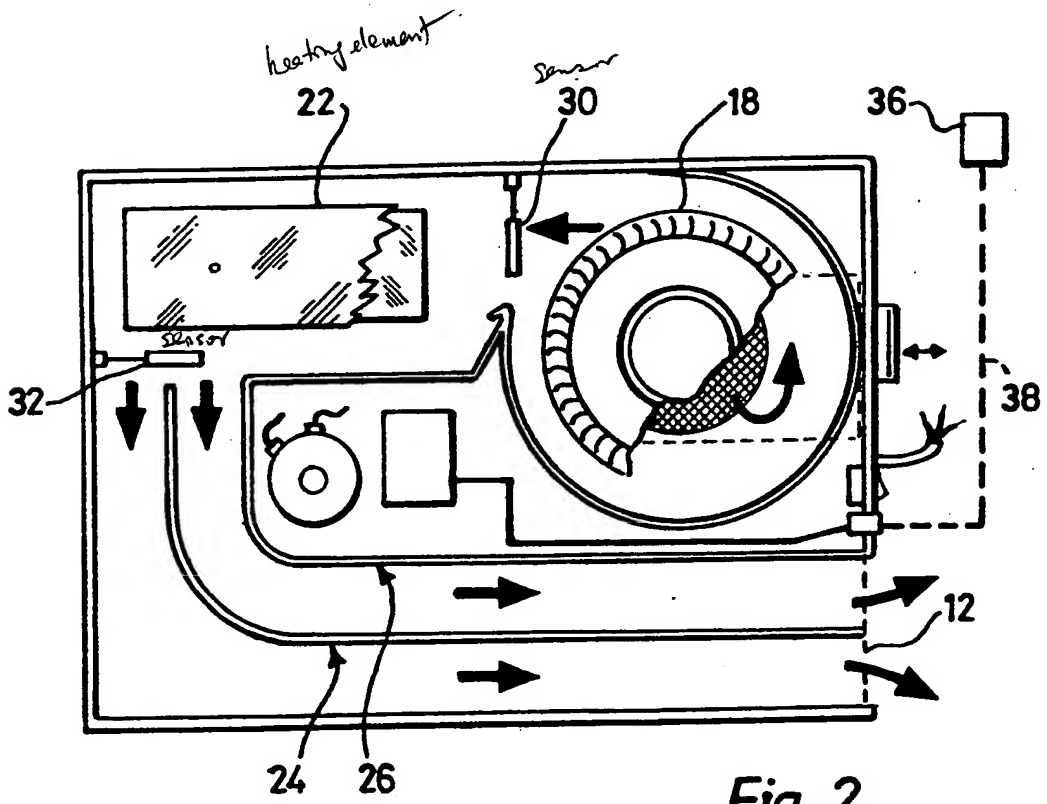

Fig. 2

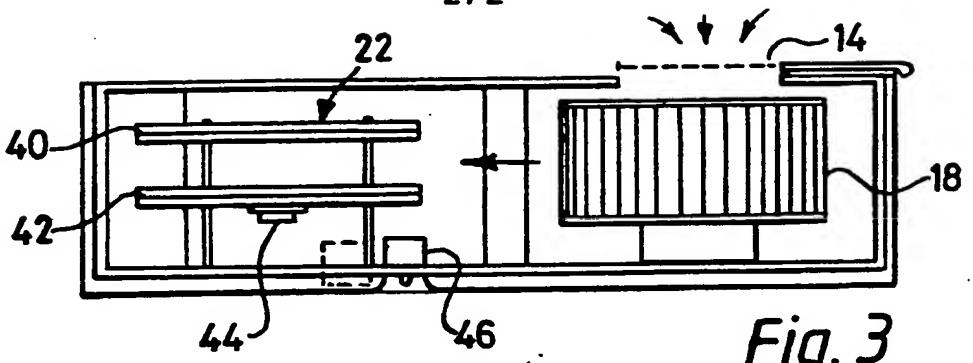

Fig. 3

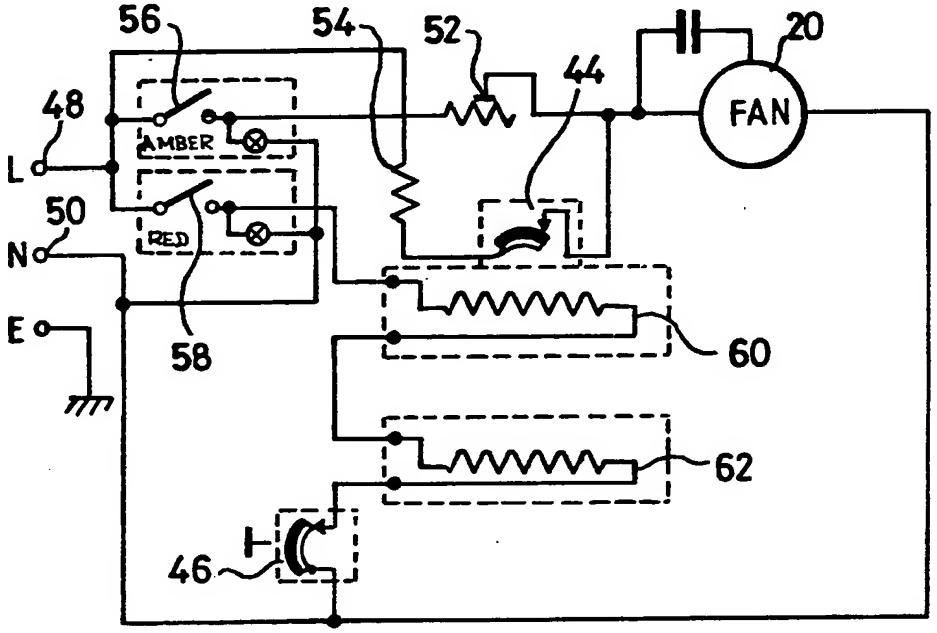

Fig. 4

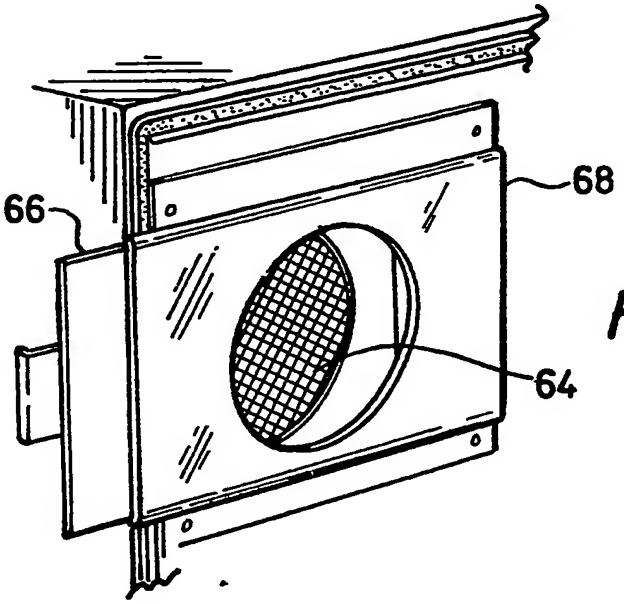

Fig. 5

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Title: Method and Apparatus for Reducing Humidity

Field of invention

This invention concerns method and apparatus for reducing the water content of the air in a building.

Background to the invention

As the temperature of air is raised so its capacity to hold moisture increases and vice versa.

If a building is empty and dry, any such rise and fall in temperature will barely be noticeable although if any part of the structure such as a window or wall becomes very cold relative to the temperature of the interior air, condensation eventually will occur as the air in the vicinity of the cold surface is chilled and gives up its moisture.

Where the building is occupied and/or includes one or more sources of water vapour the water content of the air in the building may be quite high so that quite a small fall in temperature of the air will result in water vapour in the air condensing onto the coldest surface(s) in the building. These will typically be glazed windows and doors although where double glazing is incorporated the coldest spots may be walls, ceiling, floors or surrounds or frames of windows and doors. The resulting film of water can rot timber, disfigure decor and may provide an

ideal environment for the growth of fungus and mould which can be injurious to health.

Various attempts have been made to reduce condensation but in general these methods have involved either the production of a local "cold spot" to induce local condensation with some mechanism for collecting the water which condenses or the extraction of water vapour laden air using a fan or the like. The first approach is only useful if all the air in the building can and does circulate systematically over the local "cold spot" and the second approach tends to introduce cold draughts must be drawn into the building from outside to replace the vapour laden air extracted. The extraction of the "warm" air from the building also represents a loss of the latent heat in the air in the building.

A recent attempt has involved the use of a fan adapted to extract air from the building via one side of a heat exchanger to heat up incoming air drawn from outside the building through the other side of the heat exchanger by the same fan. In theory this reduces the heat loss which otherwise would occur but the arrangement is very inefficient when the temperature differential between incoming and outgoing air is relatively small as is normally the case in temperate climates such as the United Kingdom and only minimal heating of the incoming air is achieved.

It is an object of the present invention to provide a simpler and more effective method and apparatus for reducing condensation.

Summary of the invention

According to one aspect of the present invention a method of reducing condensation in a building comprises the steps of:

(1) sensing when the humidity of the air in the building is equal to or exceeds a first predetermined value and generating a signal in response to the said sensing,

(2) in response to the signal operating air displacement means, to cause air to be drawn into the building, to thereby create a small positive pressure within the building,

(3) simultaneously operating a heating means for heating the incoming air, and controlling the heating means to turn the heater off if the temperature of the air exceeds a given value, and

(4) stopping the air displacement means and the heating means when the humidity of the air in the building drops to a second predetermined value.

The humidity sensing may be effected near the air displacement means but more preferably is effected at a position remote therefrom, so as to be unaffected by any local change in humidity of the air in the region of the air displacement means shortly after the latter starts to operate.

In a refinement of the method of the invention the temperature of the incoming air and the general air temperature within the building are both sensed and a signal generated indicative of any difference in these two

temperatures to control the quantity of heat supplied to the incoming air to thereby tend to maintain the temperature of the air entering the building at a constant value.

Conveniently the said constant value can be preset.

The heating may be controlled, for example, by altering the duty cycle of, or the amount of energy available to the heating element.

In a further refinement of the method, the rate of air flow may be adjusted and may either be presettable, or may be adjustable to give a greater or lesser exposure to the heating element, so as to alter the temperature to which the air is heated as it passes into the building.

The heating aid air displacement means may be under the control of a microprocesor controlled control unit which includes a memory into which, inter alia, information relating to the level of humidity at which the process is to begin, the temperature to which the air is to be heated, the size of the building the humidity value at which the process is to be shut down etc, can be stored, in order to achieve the desired level of control over the humidity in the building. Where such microprocessor control is incorporated the method may additionally comprise the step of entering data into the memory specific to a particular installation and/or entering data after installation in the light of changing conditions or information desired from day to day experience of the operation of the method.

Preferably a stop signal is generated when the sensed

humidity value reaches the second predetermined value to stop further operation of the air displacement means and the heating means.

Advantageously the heating means is terminated earlier than the air displacement means to enable the continuing airflow over the heating means to cool the latter.

In a further embodiment of the method the humidity of the external air is sensed by a separate humidity sensing means whereby a comparison may be made between the humidity of the incoming air (before being heated) and the humidity of the air inside the building and/or the desired humidity level within the building (ie the second predetermined humidity value), thereby to indicate whether the incoming air is sufficiently dry as to enable dehumidification of the air in the building to be achieved. Where the humidity data indicates dehumidification to the desired (second) value is impossible either an alarm may be sounded or a warning light caused to come on and/or a humidity value related to that of the outside air may be substituted for the said second humidity value or the latter value may be altered to a new value to take account of the high external humidity.

In such a condition the dehumidifier would not of course function in a manner to reduce condensation as completely as would be the case if the external air were drier, but within the constraints of the external humidity the method would at least operate as optimally as possible.

According to another aspect of the present invention apparatus for performing the method of the invention

comprises:

(1) humidity sensing means for generating signals indicative of the humidity of the air in a building,

(2) air displacement means operable to draw air into the building and resposive to signals from the sensing means for starting and stopping the said displacement means,

(3) air heating means operable in conjunction with the air displacement means to heat the incoming air, and

(4) temperature sensitive control means for reducing or turning off the heating means if the temperature of the heated air exceeds a predetermined temperature.

Conveniently the air displacement means comprises an electric motor driven fan and the heating means comprises an electric heating element.

In a preferred embodiment both the electric motor driven fan and the heating element are located in a single housing which is adapted to communicate with the air outside the building via an air intake which may communicate with a duct through a wall of the building or may itself comprise a duct adapted to extend through a hole in a wall for attachment to an inlet grill or the like fitted in the outside of the wall.

Since the method and apparatus draws air into the building, the slight positive pressure which will normally result will tend to reverse any draughts which might otherwise occur.

Since the air which is being drawn in will generally be colder than that in the building, it will in general contain less water vapour (ie be less humid) than the air in the building and after being heated will be capable of holding more water vapour. The incoming air can therefore be thought of as a water absorbing fluid which will tend to attract into itself the water vapour which would otherwise condense out preferentially onto cold surfaces in the building.

The expression "building" is intended to mean any enclosed space and may be a single room in a building (which may contain other rooms) or may refer to a part or the whole of a building containing a plurality of rooms. Where the invention is to be applied to the latter case, the rooms are to advantage provided with permanent interconnecting ducting or the like to allow for the circulation of air from one to another.

According to another feature of the invention, the air heating may to advantage be achieved by means of a heater the energy for which is provided from the main heating system employed in the building. Thus for example, where gas central heating is employed as the main source of heating, a gas powered heat exchanger may be provided, or a heat exchanger may be provided for recovering some of the heat from the hot exhaust gases from the gas central heating boiler or a water heated exchanger may be provided to extract heat from the water flowing around the central heating system, to heat up the incoming air.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a complete unit for humidity reduction for use in a system incorporating the invention;

Figure 2 is a cut-away view showing part of the interior of the device shown in Figure 1;

Figure 3 is a cut-away view from above of the device shown in Figures 1 and 2;

Figure 4 is a circuit diagram illustrating how the various parts of the unit operate, and

Figure 5 is a perspective view of a detail of the rear of the unit shown in Figure 1.

Detailed description of the drawings

As shown in Figure 1, the unit is located within a housing 10 which includes an air exit grill 12 and at the rear an air inlet opening (as seen in Figure 3). The latter is denoted by reference numeral 14.

A rotary control 16 on the front of the housing allows the speed of a fan 18 (see Figures 2 and 3) to be adjusted by limiting the current available for driving an electric motor (not shown) which powers the fan. The latter is shown diagramatically in the circuit diagram of Figure 4 at 20.

Also within the housing is an electric heating element 22 and ducting generally designated 24 and 26 defining air passages communicating between the outlet of the heating chamber generally designated 28 and the exit 12. The

purpose of the ducting is to reduce the noise of the fan to an acceptable minimum.

At the entrance to the heating element is located a first sensor 30 and at the entrance to the ducting 24, 26 is a second sensor 32. The sensor 30 is adapted to determine the temperature and/or the humidity of the incoming air whilst the sensor 32 essentially determines the temperature of the air entering the ducting. A microprocessor controlled control unit 34 is supplied with signals from the sensors 30 and 32. It is also supplied with signals from one or more remote sensors such as 36 (see Figures 1 and 2)-for determining the humidity and/or temperature of air remote from the position from unit 10. To this end a cable 38 connects the remote sensor or sensors to the unit.

The heating element 22 is formed from two plates 40 and 42 as best seen in Figure 3 which comprise a resistive heating element and on one of the plates is mounted a temperature sensitive switch whose contacts are closed when the temperature of the switch exceeds a threshold, which may be adjustable. The switch remains closed until the temperature of the switch drops again below the threshold.

Within the cabinet 10 is located an ambient temperature sensing switch 46 the contacts of which remain closed until the ambient temperature reaches a predetermined value which may be adjustable but open above that temperature.

The basic circuit of the device is shown in Figure 4. The Live and Neutral of an electrical distribution network are

connected to junctions 48 and 50 and the fan motor is powered through the variable resistor 52 associated with the rotary control 16 and additionally via a line resistor 54 and the switch 44. An ON/OFF switch 56 when open prevents current from reaching the motor and will normally turn the fan off. If however, the switch contacts 44 are closed (due to the heating element having been operated) a current path will remain via resistor 54 and switch 44 to enable the fan to operate even after the switch 56 has been opened. Current will continue to flow to cause the fan to operate until such time as the temperature of the heating device has dropped below the threshold at which the switch contacts 44 open.

A second switch 58 enables current to flow via the two resistive heating elements 60 and 62 and the normally closed contacts of switch 46. In the event of overheating in the compartment, switch 46 opens thereby removing the source of heat.

The switch 46 is a so-called trip switch and does not automatically reset when the temperature drops. Instead a push-button 64 is provided by which the switch can be reset to re-enable the heating element in the event of an overheating situation.

Conveniently the push-button 64 protrudes noticeably in the event of an overload.

Although not shown, interconnection is provided between the microprocessor controlled control unit 34 and the fan and heater circuits to enable and/or inhibit the flow of current in both circuits in the event of particular temperature or humidity levels being reached. Thus, for

example, a signal from humidistat 36 is arranged to turn the fan and heater ON and a further signal generated by the control unit 34 is arranged to turn the fan and heater OFF (subject to the operation of switch 44 as described above), after the humidistat reading drops below a lower level.

Temperature and/or humidity information derived by sensors 30 and 32 is supplied to the control unit 34 directly and the latter is for example programmed to adjust an electrical threshold with which an electrical signal whose value is proportional to the humidity (measured by the humidistat 36), is compared to determine when the desired level of humidity has been achieved. Where the incoming air is sufficiently dry, (as measured by humidistat 30) a relatively low humidity level can be set for the target value of the humidity in the room or building in which the unit is mounted. Where however the humidity of the air being drawn into the device is relatively high (as determined by humidistat 30) so a higher target value at which the fan is turned OFF will have to be accepted since not to do so would merely introduce into the room or building more and more relatively high humidity air to no purpose.

In order to minimise the ingress of dirt and the like, a filter is provided in the form of a screen 64 mounted within a slide 66 held captive in a slide housing 68. The slide 66 can be pulled out of the housing 68 to enable the screen 64 to be cleaned or replaced.

Although not shown in the drawings, the heating element may be replaced by a water heat exchanger (or an air to air) heat exchanger and provision made for connecting the

water (or air) inlets and outlets either into a closed circuit central heating system (or to receive and exhaust the hot exhaust gases from a boiler such as an oil fired or gas fired boiler). Where such heat exchangers are employed, the temperature sensitive switches 44 and 46 would be either omitted or modified since there would be little chance of any overheating occurring and there would probably be no need to run the fan motor 20 after the heating current has been switched off to prevent the heater from overheating due to the lack of passage of air thereover.

It is to be noted that switch 44 not only serves as a time-out switch to run the fan for a period of time after the heating element has been operated, but also serves as a safety device. This in the event of switch 58 being closed but not switch 56, the fan motor will very shortly thereafter be operated due to the current path through resistor 54 and the switch 44 which will operate to close its contacts as soon as the temperature of the heating element 60, rises. In that situation the fan will remain operating for all of the time that the heating element is itself operating due to the closing of the contacts of switch 44.

Although not expressely mentioned, the air inlet 14 for the fan 18, is covered by the housing 68 (see Figure 5) and the screen 64 provides a filter over the inlet 14 so as to minimise the ingress of dirt and airborne particles.

The invention is of particular application in domestic dwellings where condensation due to falling air temperatures at night, particularly in rooms which are or

have been occupied is a serious problem. By locating the humidistat 36 at a convenient point within a room, so the device can be made to operate whenever the humidity in the room exceeds a certain predetermined level which can be preset either at the factory during assembly or if an adjustable control is provided, by adjustment on installation or in use, so as to introduce into the room through the outlet 12, heated exterior air which by virtue of its lower temperature to start with will normally be much drier than the air in the room. The incoming warm dry air thus acts as a "water absorbing fluid" and apart from displacing humid air out of the room via the natural cracks and exits, mixes with the humid air in the room to "soak up" the moisture in the air to reduce the risk of condensation occurring.

Claims

1. A method of reducing condensation in a building comprising the steps of: sensing when the humidity of the air in the building is equal to or exceeds a first predetermined value and generating a signal in response to the said sensing; operating an air displacement means in response to said signal to cause air to be drawn into the building and to thereby create a small positive pressure within the building; simultaneously operating a heating means for heating the incoming air, and controlling the heating means to turn the heater off if the temperature of the air exceeds a given value; and stopping the air displacement means and the heating means when the humidity of the air in the building drops to a second predetermined value.

2. A method according to claim 1 in which the humidity sensing is effected at a position remote from the air displacement means, so as to be unaffected by any local change in humidity of the air in the region of the air displacement means shortly after the latter starts to operate.

3. A method according to claim 1 or claim 2 further comprising the step of sensing both the temperature of the incoming air and the general air temperature within the building, and generating a signal indicative of any difference in these two temperatures to control the

quantity of heat supplied to the incoming air, to thereby tend to maintain the temperature of the air entering the building at a constant value.

4. A method according to claim 3 in which said constant value is pre-set.

5. A method according to any one preceding claim in which the heating is controlled by altering the duty cycle of, or the amount of energy available to, the heating means.

6. A method according to any one preceding claim in which the rate of air flow is adjustable or pre-settable to give a greater or lesser exposure to the heating means, so as to alter the temperature to which the air is heated as it passes into the building.

7. A method according to any preceding claim in which the heating and air displacement means is under the control of a microprocessor-controlled unit which includes a memory in which can be stored, inter alia, information relating to the level of humidity at which the process is to begin, the temperature to which the air is to be heated, the size of the building and the humidity value at which the process is to be shut down, in order to achieve the desired level of control over the humidity in the building.

8. A method according to claim 7 and further comprising the step of entering data into the memory specific to a particular building installation and/or entering data after installation in the light of changing conditions or information desired from day to day experience of the operation of the method.

9. A method according to any one preceding claim in which a stop signal is generated when the sensed humidity value reaches said second predetermined value, to stop further operation of the air displacement means and the heating means.

10. A method according to any one preceding claim in which the heating means is terminated earlier than the air displacement means to enable the continuing airflow over the heating means to cool the latter.

11. A method according to any one preceding claim in which the humidity of the external air is sensed by a separate humidity sensing means, whereby a comparison is made between the humidity of the incoming air (before being heated) and the humidity of the air inside the building and/or the desired humidity level within the building (ie the second predetermined humidity value), thereby to indicate whether the incoming air is sufficiently dry as to enable dehumidification of the air in the building to be achieved.

12. A method according to claim 11 in which, when the humidity data indicated dehumidification to the desired (second) value is impossible, an alarm is sounded or a warning light caused to come on, and/or a humidity value related to that of the outside air is substituted for the said second humidity value or the latter value is altered to a new value to take account of the high external humidity.

13. Apparatus for reducing condensation in a building comprising: humidity sensing means for generating signals

indicative of the humidity of the air in a building; air displacement means operable to draw air into the building and responsive to signals from the sensing means for starting and stopping said displacement means; air heating means operable in conjunction with the air displacement means to heat the incoming air; and temperature sensitive control means for reducing or turning off the heating means if the temperature of the heated air exceeds a predetermined temperature.

14. Apparatus according to claim 13 in which the air displacement means comprises an electric motor driven fan, and the heating means comprises an electric heating element.

15. Apparatus according to claim 14 in which both the electric motor driven fan and the heating element are located in a single housing which is adapted to communicate with the air outside the building via an air intake; which communicates with a duct through a wall of the building or itself comprises a duct adapted to extend through a hole in a wall for attachment to an inlet grill or the like fitted in the outside of the wall.

16. Apparatus according to any one preceding claim in which the air heating is achieved by means of a heater the energy for which is provided from the main heating system employed in the building, eg a heat exchanger for recovering some of the heat from the hot exhaust gases from a gas central heating boiler, or a water heated exchanger to extract heat from the water flowing around a central heating system, to heat up the incoming air.

17. A method of reducing condensation in a building

substantially as herein described with reference to, and as shown in, the accompanying drawings.

18. Apparatus for reducing condensation in a building substantially as herein described with reference to, and as shown in, the accompanying drawings.

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